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FAIRING SUPPORT RINGS FOR AN/SQA-10 VARIABLE DEPTH SONAR TOWCAB--ETC(U)

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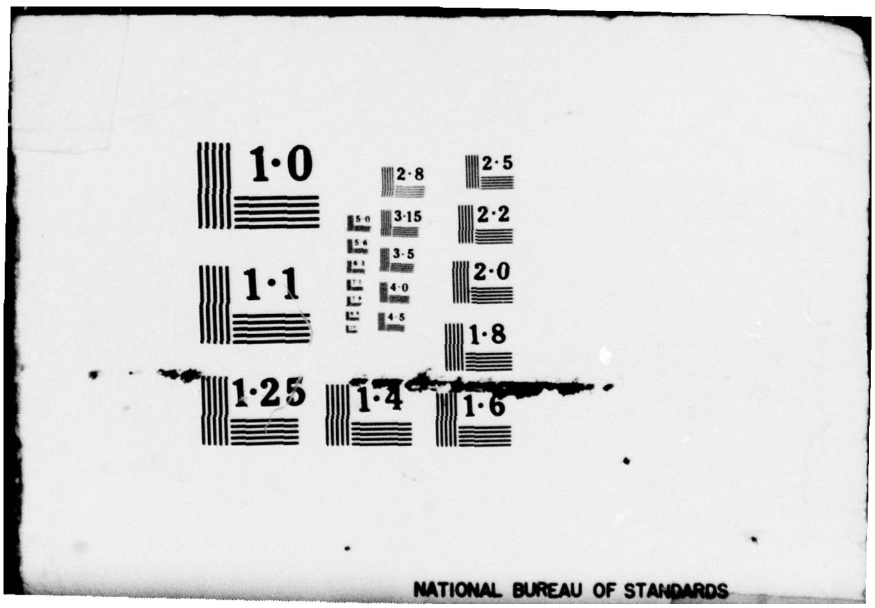
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TECHNICAL MEMORANDUM

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FAIRING SUPPORT RINGS

FOR

AN/SQA-10 VARIABLE DEPTH SONAR TOWCABLES

Lab. Project 9400-97

9 Technical Memo... dum #9

Subproject S2720, Task 11309

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10 C. Francy

S. A. Eller

MATERIAL SCIENCES DIVISION

Approved: D. H. Kallas

D. H. KALLAS

Associate Technical Director

U.S. NAVAL APPLIED SCIENCE LABORATORY

NAVAL BASE

BROOKLYN, NEW YORK 11251

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Lab. Project 9400-97
Technical Memorandum #9

ABSTRACT

The U.S. Naval Applied Science Laboratory has developed a fairing support ring for AN/SQA-10 Variable Depth Sonar (VDS) towcables. These fairing support rings are suitable for use with either sectional plastic fairing or rubber fairing in discrete lengths. The NASL fairing support ring is expected to assist in decreasing towline kiting associated with presently used AN/SQA-10 towlines by limiting the transfer of drag forces between fairing sections. Arrangements to install these rings on six AN/SQA-10 towlines for fleet use have been made in cooperation with the U.S. Navy Underwater Sound Laboratory.

ADMINISTRATIVE INFORMATION

Ref: (a) NASL Program Summary of 1 December 1965, Subproject S2720, Task 11309 "Sonar Fleet Support"
(b) NASL Technical Memorandum #1, Lab. Project 6364 of 19 September 1963
(c) NASL Technical Memorandum #3, Lab. Project 6364 of 5 August 1964

Table: I Load Carrying Capacity of NASL Fairing Support Rings

Figure: (1) Photo L20011-1, Apparatus Used to Determine Load Carrying Capacity of NASL Fairing Support Rings.

(2) Photo L20011-2, Towcable Flexing Apparatus Used for Simulated Service Tests of Fairing Support Rings.

(3) Photo L20011-3, Cross Section of Fairing Support Ring on Towcable Showing Position of Thermocouple.

(4) Photo L20011-4, Fairing Support Ring After 20,000 Cycles of Operation on Towcable Flexing Apparatus.

(5) Graph Sheet, Temperature Rise of Sheathing Material During Molding of Fairing Support Ring.

Appendix: (A) Procedure for Applying NASL Fairing Support Rings to AN/SQA-10 Towcables.

1. In accordance with the objectives set forth in reference (a), NASL is conducting a fleet support program directed toward the development of fairing support rings for the AN/SQA-10 VDS system. This memorandum summarizes the work performed to develop the fairing support rings and includes an illustrated procedure for applying the rings to AN/SQA-10 towcables.

ACKNOWLEDGEMENT

2. This work was performed under the general guidance of Mr. C. K. Chatten, Head, Plastics and Elastomers Branch, who is Laboratory Program Manager for VDS tasks. The BUSHIPS Program Manager is Mr. J. F. Glitzner (Code 1633D).

INTRODUCTION

3. The present AN/SQA-10 VDS towline, which is equipped with sectional plastic fairing, has exhibited a tendency to kite, thereby reducing the effectiveness of the VDS system. One possible explanation of kiting is that the drag forces on the sections of fairing create excessive binding between adjacent fairing sections which prevents them from swiveling freely around the towcable to conform with the water flow. This misalignment of the fairing section may thus cause the towline to kite.

4. Utilizing the experience gained from the work reported in references (b) and (c), NASL developed a fairing support ring for the AN/SQA-10 VDS towcables, described herein. USL believes that spacing of fairing support rings at 20 feet intervals along the towcable will minimize the tendency of sectional plastic fairing to kite, as they will limit transfer of drag forces between fairing sections.

5. *The objectives of this investigation are to:*

a. Develop a fairing support ring compatible with the AN/SQA-10 VDS system which is capable of withstanding service conditions.

b. Prepare a procedure and specification for applying fairing support rings to AN/SQA-10 towcables.

PROCEDURE

6. The load carrying capacity of fairing support rings was determined using the apparatus shown in Figure 1. The rings were molded onto 1 1/2 foot long lengths of AN/SQA-10 towcable using the procedure described in Appendix A. A load of 20,000 pounds, as indicated by the strain indicator, was applied onto the towcable by the cable tension screw. The Instron testing machine was then operated at a load rate of 900 pounds per minute to shear the fairing support ring from the towcable. The load carrying capacity and deflection under load were measured on rings tested in the initial "as molded" condition and after immersion in synthetic sea water

at atmospheric pressure for 34 days.

7. The ability of the fairing support rings to withstand cyclic flexing while being worked on and off a sheave was investigated using the flexing machine shown in Figure 2. To accomplish this, four rings were molded onto a 14 foot length of AN/SQA-10 towcable using the procedure described in Appendix A. The towcable was mounted in the flexing machine and flexed at the rate of 15 cycles per minute over a 50 inch diameter sheave while under a tensile load of 12,000 pounds. Two of the rings were positioned so that they worked on and off the sheave during each flexing cycle whereas the other two rings remained continuously on the sheave. The towcable was equipped with sections of plastic fairing machined to fit around the rings to simulate service conditions. Periodic qualitative examinations were made on the rings during the flexing test. In addition, instrumentation was set up to determine whether cyclic flexing of the rings would cause the electrical conductors to break or short circuit. After 20,000 flexing cycles, the towcable was removed from the flexing machine and the load carrying capacity of the fairing support rings was determined.

8. The effect of heat and pressure incident to the fairing support ring application process on the underlying electrical conductor sheath material was investigated by placing a thermocouple beneath the inner and outer armor wire lays and in contact with the sheath material, as shown in Fig. 3. A ring was then molded onto the towcable over the thermocouple and the temperature at the sheath material was measured at one minute intervals during the molding operation.

9. The effect of the applied fairing support rings on the properties of the electrical conductors was investigated by molding five rings onto a 10 foot length of towcable and measuring the change in insulation resistance and capacitance of the conductors.

RESULTS

10. The load carrying capacity and the deflection of the fairing support rings along the towcable at 2,000 pounds load, tested in the "as molded" condition, after immersion for 34 days in synthetic sea water at atmospheric pressure, and after 20,000 flexing cycles over a 50 inch diameter sheave are tabulated in Table I. The decrease in load carrying capacity from 3,900 pounds in the "as molded" condition to 2,250 pounds after immersion in the synthetic sea water is believed due to improperly adhered rings.

11. Figure 4 shows a fairing support ring after 20,000 cycles of working on and off the 50 inch diameter sheave. As shown in Figure 4, there was no visible damage to the ring other than a slight rounding at the edges. In addition, there was no change in the electrical properties of the towcable

as a result of the 20,000 cycle flexing test.

12. The temperature rise of the sheath material during the molding of a fairing support ring is shown in Figure 5. The maximum temperature attained by the sheath material was 255F, reached after molding the ring for 10 minutes. At this time, the ring was removed from the mold and permitted to cool. Although 255F exceeds the safe operating temperature of 240F for the polychloroprene sheath material, the difference is relatively small and the length of time at the higher temperature is only 5 minutes. Visual examination of the dissected cable revealed no deterioration of the sheath material. Accordingly, the Laboratory believes that molding rings onto the towcable will not damage the sheath material and its underlying conductors. This statement is substantiated by the fact that 20,000 flexing cycles of the rings on and off the 50 inch diameter sheave had no apparent effect on the electrical conductors.

13. There was no change in the insulation resistance and capacitance of the electrical conductors as a consequence of molding five rings onto the towcable.

CONCLUSION

14. The NASL fairing support ring will satisfactorily support a shear load of over 2,000 pounds while there is a tensile load of 20,000 pounds on the towcable.

15. The reduction in load carrying capacity of the rings from 3,900 pounds in the "as molded" condition to 2,250 pounds after immersion in synthetic sea water is attributed to improperly formed rings. Despite this, the rings still withstood a greater load than they are expected to encounter in service.

16. The fairing support rings satisfactorily withstood flexing for 20,000 cycles on and off a 50 inch diameter sheave without detrimental effect on the rings and on the electrical conductors.

17. Molding NASL fairing support rings on AN/SQA-10 towcables had no apparent effect on the electrical conductors.

RECOMMENDATION

18. It is recommended that NASL fairing support rings, applied to towcables in accordance with the procedure described in Appendix A, be used to support sectional plastic fairing and discrete lengths of rubber fairing on AN/SQA-10 towcables.

FUTURE WORK

19. USL plans to equip six AN/SQA-10 towlines with NASL fairing support rings and to service test the towlines in the Fleet. NASL will periodically follow-up on the performance of these rings and make whatever improvements are necessary.

20. NASL plans to procure an AN/SQA-10 towline equipped with 15 foot lengths of butyl rubber fairing, each length suspended from a NASL fairing support ring. This towline will be subjected to sea trial tests and then left in the Fleet for service tests.

21. In addition, NASL will work on the development of fairing support rings for the AN/SQA-13 VDS system, which will eventually replace the AN/SQA-10 system.

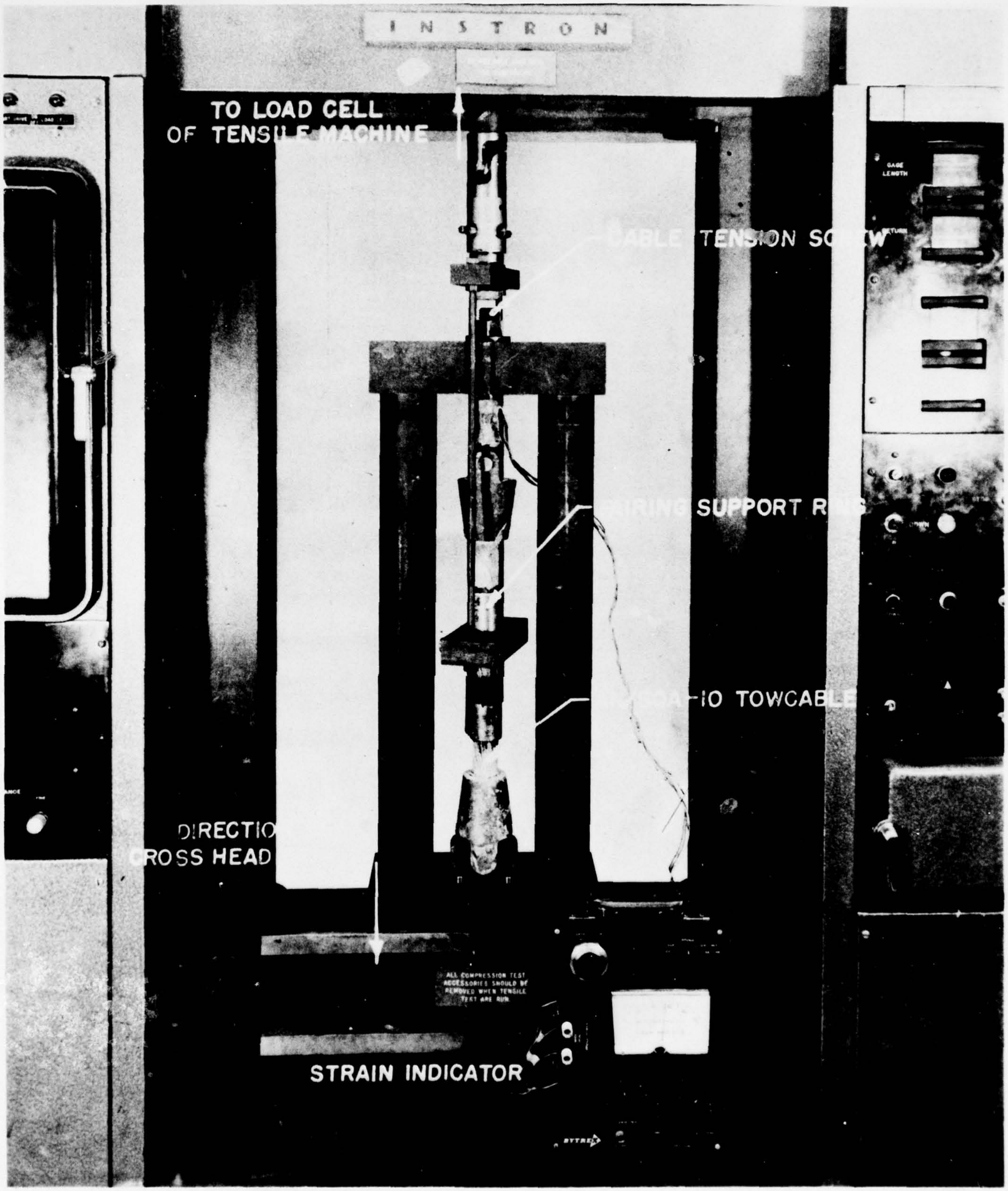

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FIGURE 1 - APPARATUS USED TO DETERMINE LOAD CARRYING CAPACITY OF NASL FAIRING SUPPORT RINGS.

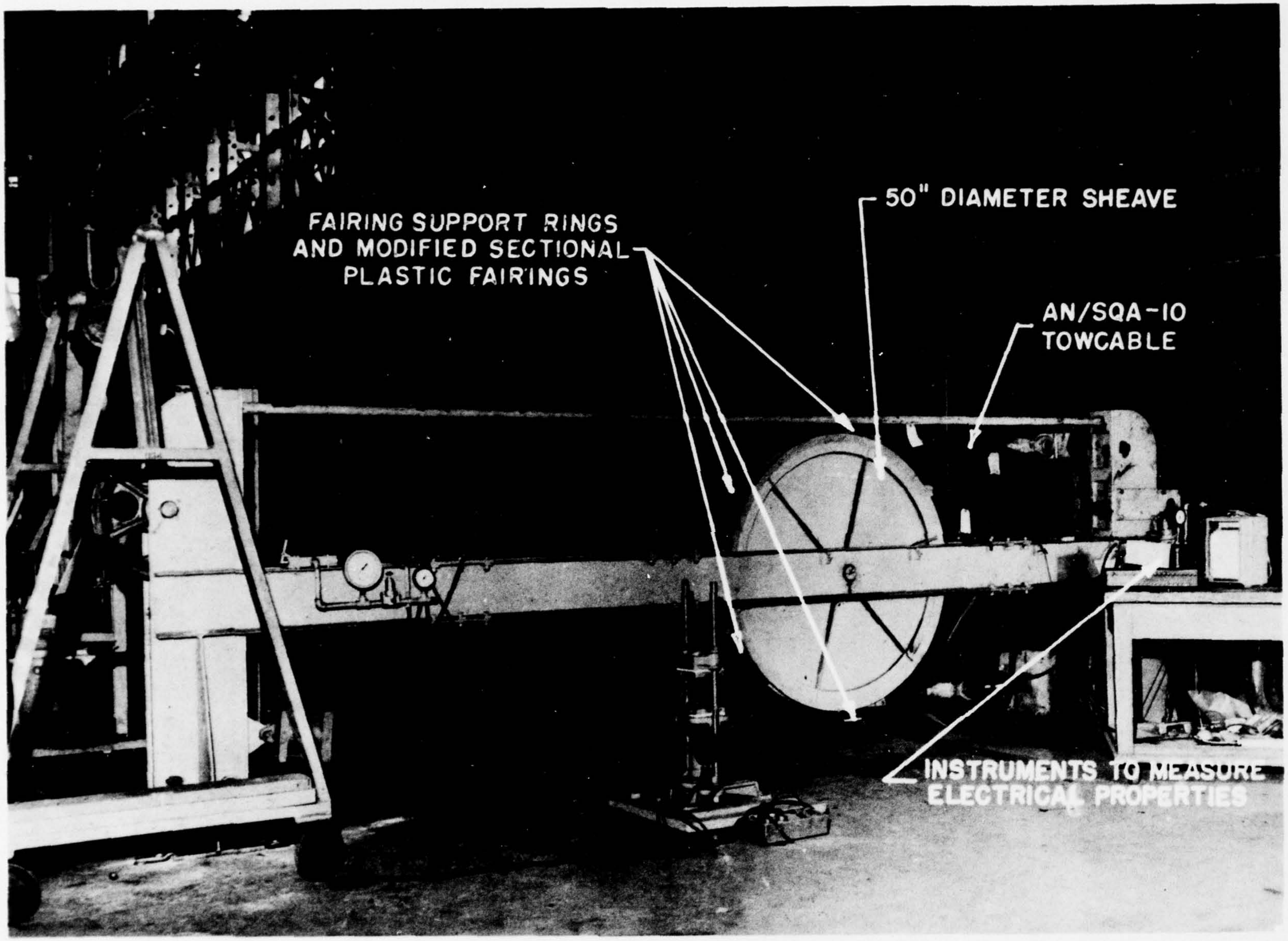

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FIGURE 2 - TOWCABLE FLEXING APPARATUS USED FOR SIMULATED SERVICE TESTS OF FAIRING SUPPORT RINGS

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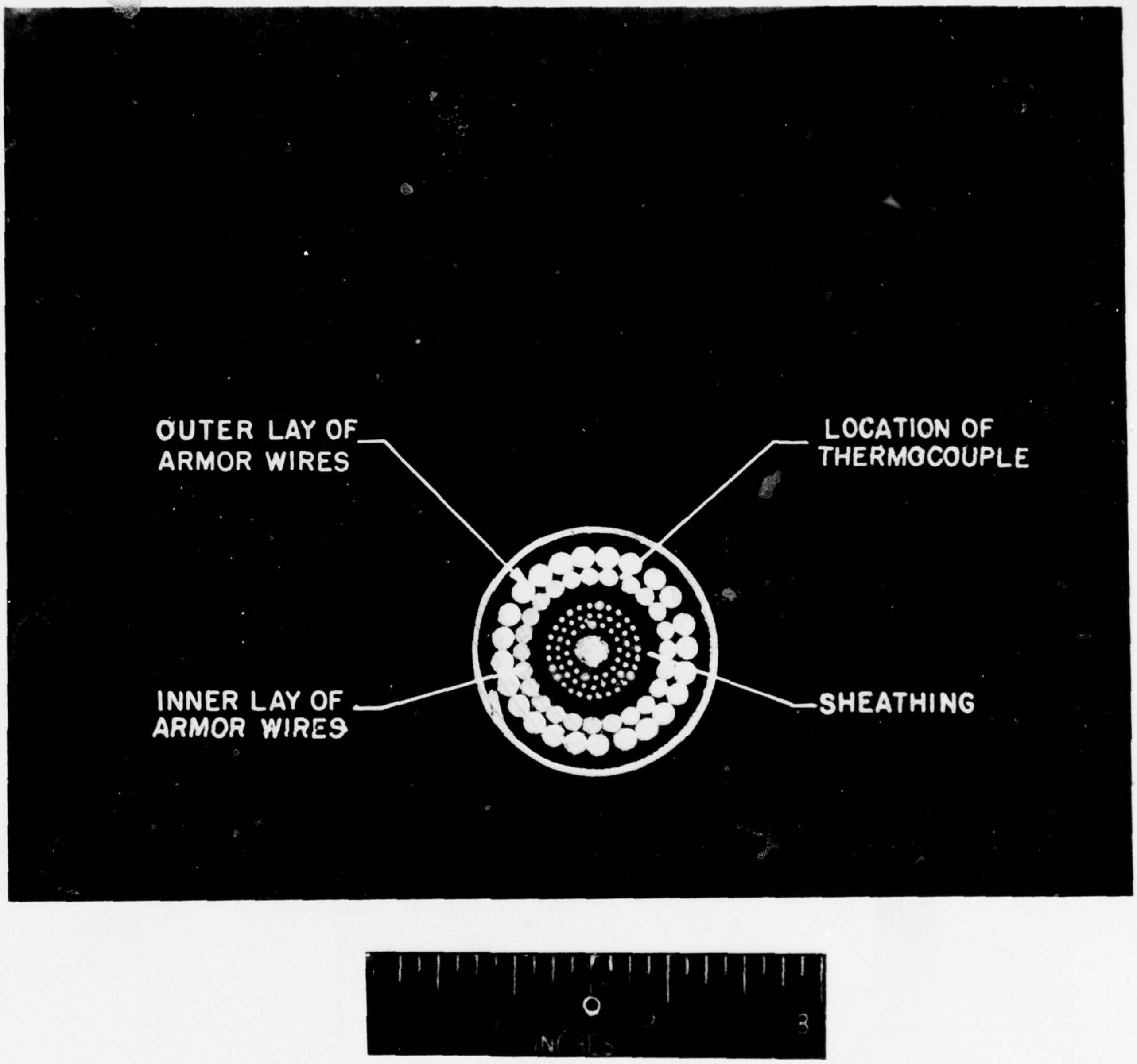

PHOTO L 20011-3

FIGURE 3 - CROSS SECTION OF FAIRING SUPPORT RING ON TOWCABLE SHOWING POSITION OF THERMOCOUPLE

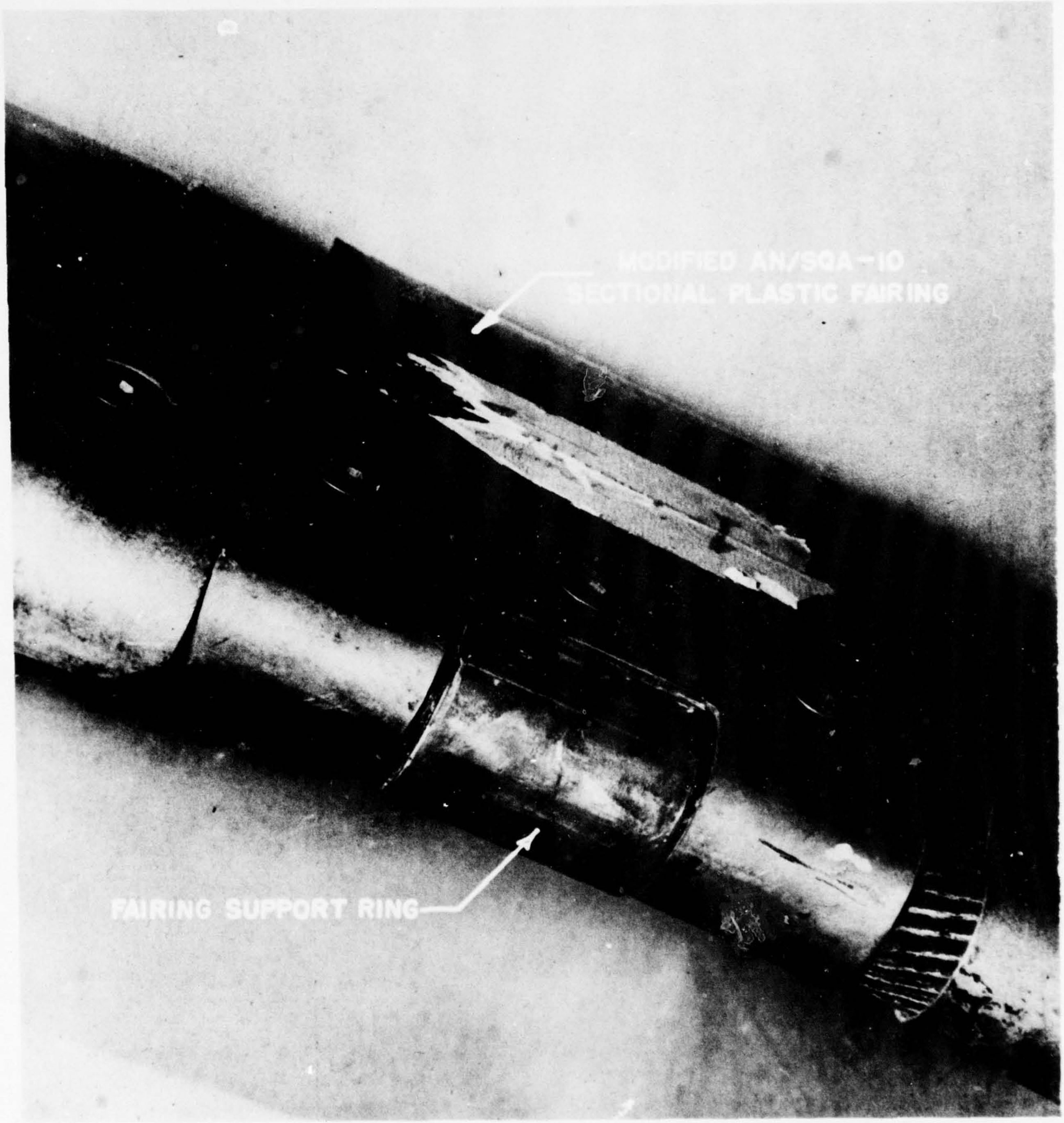

PHOTO L 20011-4

FIGURE 4 - FAIRING SUPPORT RING AFTER 20,000 CYCLES OF OPERATION ON TOWCABLE FLEXING APPARATUS

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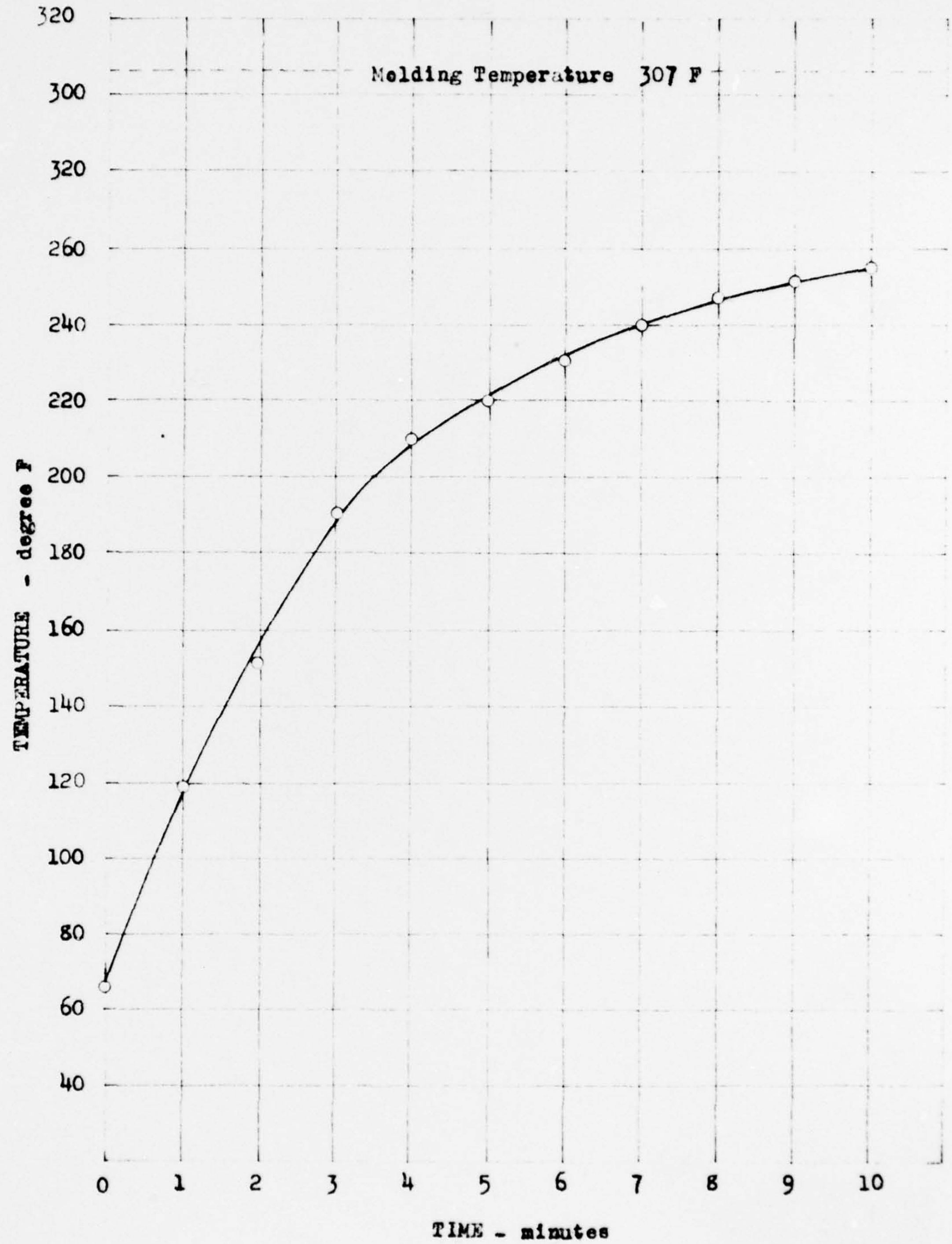


Figure(5) - Temperature Rise of Sheathing Material During Molding of Fairing Support Ring

TABLE I

LOAD CARRYING CAPACITY OF NASL FAIRING SUPPORT RINGS

Description of Simulated Service Test Conditions	Load Carrying Capacity, Lbs.	Deflection of Ring Along Towcable at 2,000 Pound Load, Inches	Remarks
As Molded	3,000	0.19	Results are an average of eight tests.
After immersion for 34 days in synthetic sea water at atmospheric pressure	2,250	0.20	(1) There was slight corrosion around the lap weld of the fairing support ring. (2) Results are an average of two tests.
After 20,000 flexing cycles over a 50 inch diameter sheave	3,400	0.25	(1) There was no surface damage to the fairing support ring. (2) There was no damage to the electrical conductors. (3) Results are an average of two tests.

Lab. Project 9400-97
Technical Memorandum #9

Appendix A

Procedure for Applying NASL Fairing Support Rings To AN/SQA-10 Towcables

(1) Fig. A1 shows the shop drawing for the NASL fairing support ring. Fig. A2 shows the shop drawing for the mold used in applying the ring to the towcable.

Preparation of AN/SQA-10 Towcable

(2) Fig. A3 shows the towcable before removal of grease and dirt.

(3) Mark the towcable 1-3/4 in. on each side of the centerline where the ring will be positioned. Wrap masking tape or equivalent material around the cable to delineate a work area 3-1/2 in. wide (refer to Fig. A4).

(4) Wire brush the cable work area. Make sure to completely remove all traces of grease and dirt located between the first lay of armor wires (refer to Fig. A5)

(5) Degrease the wire brushed area by wiping it several times with a cloth dampened with solvent (xylene or acetone). If there is any grease or dirt remaining after the above cleaning operations, remove by using a wire brush dipped in solvent. After wire brushing, wipe the work area several times with a cloth dampened with clean solvent (refer to Fig. A6).

(6) Dry the work area with cold air from an air blower similar to the one shown in Fig. A7. Do not use compressed air.

(7) Brush a phosphoric acid mixture (80% by volume) onto the cleaned cable area (refer to Fig. A8). Allow the acid to remain on the cable for approximately one minute, then remove by repeated dousing with water. Remove water from work area using a clean dry cloth.

(8) Again, wipe the work area several times with a clean cloth dampened with solvent. Use the solvent moderately to prevent excess solvent from coming into contact with the underlying electrical conductor sheath material. Dry the area for several minutes using cold air from air blower.

(9) Stir Thixon P-4 Adhesive for about 15 minutes using a small laboratory mixer or equivalent, see Fig. A9. Cover the can of adhesive while stirring to prevent evaporation of adhesive's solvents. Note: Thixon P-4 adhesive is available from the Dayton Chemical Products Laboratory, Inc., West Alexandria, Virginia.

(10) Brush one smooth coat of adhesive onto the work area. Make sure the adhesive covers the cable completely, including portions between the outer armor wires (refer to Fig.A10). Allow the adhesive to dry for at least 30 minutes, then remove masking strips.

Preparation of Fairing Support Ring

(11) Fig. A11a shows the fairing support ring as manufactured. Open the ring to a C-shape so that it can later be easily slipped over the cable. Sandblast the inside surface of the ring (refer to Fig. A11b), then brush it with solvent to remove sand, dust or grease remaining after sandblasting. Dry the solvent cleaned surface of the ring with cold air from the air blower.

(12) Brush one smooth coat of well mixed Thixon P-4 adhesive onto the inside surface of the ring. Allow the adhesive to dry for at least 30 minutes.

Preparation of Rubber

(13) Prepare the uncured nitrile rubber compound, NASL-V740, in accordance with the instructions given in Table A1. The basic ingredients used in the compound may be obtained from the sources given in Table A2.

(14) Cut the uncured 3/16 in. thick rubber into strips 2 in. wide by 5 in. long (refer to Fig. A 11c). Place one strip of uncured rubber inside the fairing support ring, as shown in Fig. A 11d. Remove any rubber extending beyond the surfaces of the ring. Slip the ring and rubber over the cable and squeeze the ring together, by hand, as in Fig. A12.

Molding the Fairing Support Ring onto Towcable

(15) Preheat the mold to $307^{\circ}F \pm 2^{\circ}F$ in an electrically heated hydraulic press as in Fig. A15. Wear asbestos gloves when handling the heated mold.

(16) Place the fairing support ring and cable assembly in the bottom half of the heated mold as shown in Figs. A13a and A13b. Make sure that the ring is centered on the adhesive coated area. Also, make sure that the seam of the ring is contained in the top half of the mold, see Figs. A13 and A14. Place the top half of the mold on the ring as in Fig. A14. Since the mold has been preheated to $307^{\circ}F$, the ring positioning operations mentioned above should be performed within 2 minutes so that the mold does not cool excessively.

(17) Slide the ring, mold and cable assembly into the heated hydraulic press. Close the press slowly while watching the ring. If the ring turns within the mold so that the seam coincides with the separation line of the mold, open the press and remove the assembly. Reposition the ring within the mold, slide the assembly back into place and close the press slowly; again, taking care that the seam line does not coincide with the separation line of the mold. When the mold is fully closed, apply a minimum force of 24,000 pounds for 10 minutes (refer to Fig. A15). Then open the press, remove the assembly and pry open the mold. The fairing support ring should look like the ring shown in Fig. A16. Place the empty mold back into the press to reheat it for the next ring.

(18) Remove the flash (excess rubber) from the ring, taking special care to remove the flash located at the seam. This is necessary because rubber at this location will hinder the subsequent welding operation.

(19) Make a 3/4 to 1 in. long tack weld, centrally located on the seam, as in Fig. A17. Use a flux coated, 1/16 in. diameter stainless steel welding rod such as Racalloy 308 ELC, formula SA-94-A, Class I manufactured by the Reid-Avery Co., Baltimore 22, Maryland. During the welding operation, exercise care not to burn a hole through the seam and excessively damage the rubber. The following precautions should be taken:

a. Use a small to moderate DC current.

b. Make the weld with only one pass of the welding rod.

If a hole is burned through the seam, do not attempt to seal it by welding. Instead, weld on both sides of the hole so that the total length of the weld, excluding the hole, is 3/4 to 1 in. long. As soon as the welding operation starts, the rubber directly under the seam will burst into flame. Extinguish the flame quickly after the welding operation is completed.

(20) Grind the weld to match the surface of the ring, as shown in Fig. A18.

Table A1

Recipe and Milling Instructions for Nitrile Rubber Compound
NASL-V740

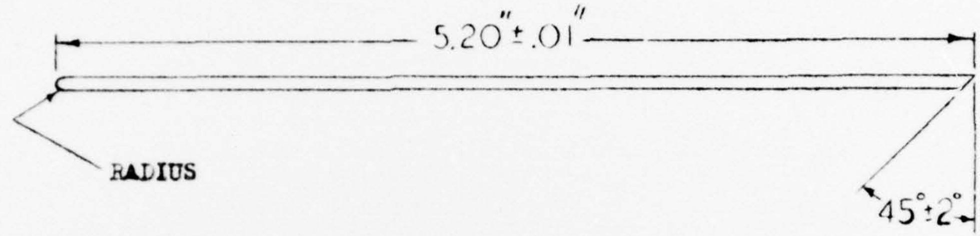
Ingredient	Concentration, parts per 100 parts of raw polymer
Hycar 1042 (raw polymer)	100
FEF Carbon Black (Philblack A)	60
Zinc Oxide	5
Maglite D	4
Stearic Acid	1
D.O.T.G.	0.5
Captax	1.5
Sulfur	2

Mill Mixing

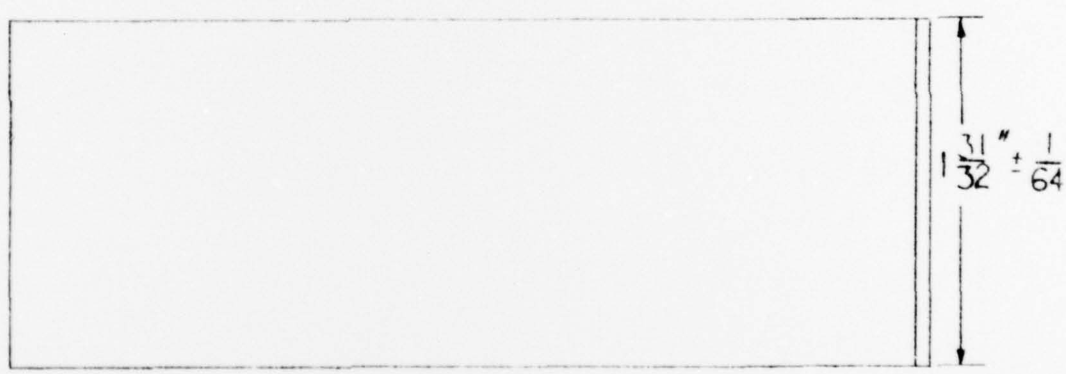
Band polymer. Add zinc oxide to 1/2 of the black and mill mix into polymer. Mix the stearic acid, Maglite D, and D.O.T.G. with the other 1/2 of the black and mill mix into polymer. Add the Captax and sulfur. Cut, refine and sheet off to a thickness of 3/16 inch. Total milling time is 25 minutes.

Table A2
Suppliers of Ingredients for Nitrile
Rubber Compound NASL-V740

Ingredient	Supplier
Hycar 1042	B. F. Goodrich Co. 500 S. Main St.,Akron 18,Ohio
FEF Black (Philblack A)	Phillips Chemical Co. 318 Water St., Akron 8, Ohio
Zinc Oxide	New Jersey Zinc Co. 160 Front St., N.Y.C. 38, N.Y.
Maglite D	C.P. Hall Co. 414 S. Broadway, Akron 8, Ohio
Stearic Acid	Emery Industries, Inc. 4300 Carew Tower Cincinnati 2, Ohio
D.O.T.G.	E.I. duPont de Nemours Co. Wilmington 98, Delaware
Captax	R.T. Vanderbilt Co. 230 Park Avenue New York City 17, N.Y.
Sulfur	Akron Chemical Co. 255 Fountain St. Akron 4, Ohio

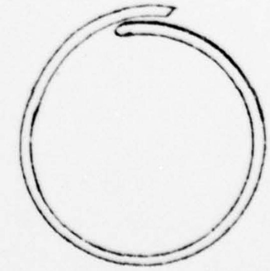


Break all sharp corners
Remove all burrs

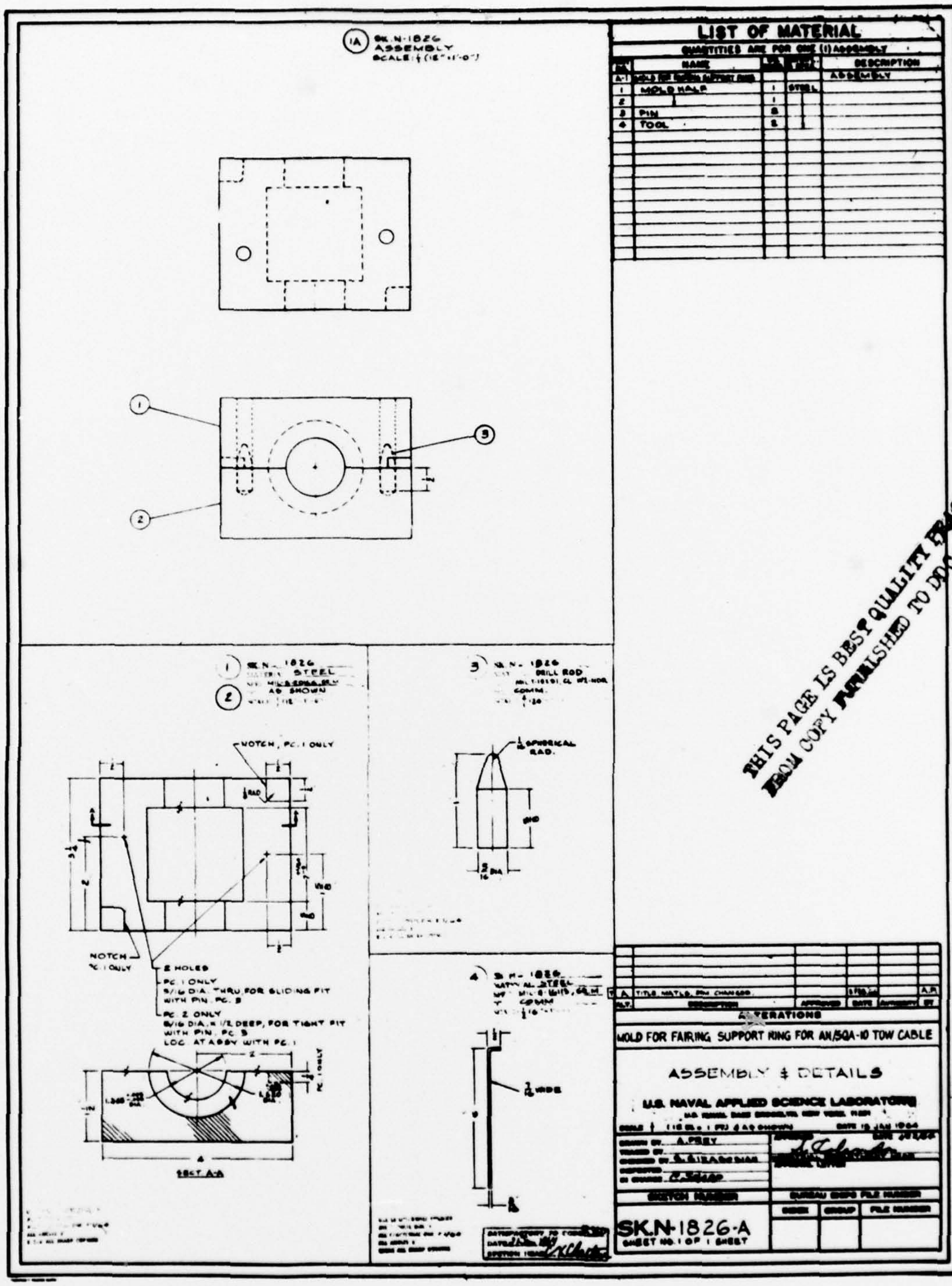


Material: #18 Gage Type 316 Stainless Steel

Prepare sheet metal strip as per above sketch. Then bend strip around 1 3/8 in. diameter mandrel to form coil as shown.



Figure(A1) - Sketch of Fairing Support Ring for AN/SQA-10 Towcables



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Figs. A2- Sketch of Mold for Fairing Support Ring for AN/SQA-10 Towcable

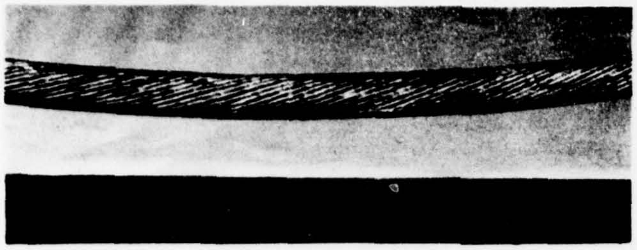

Fig. A3 - Towcable before removal of grease and dirt

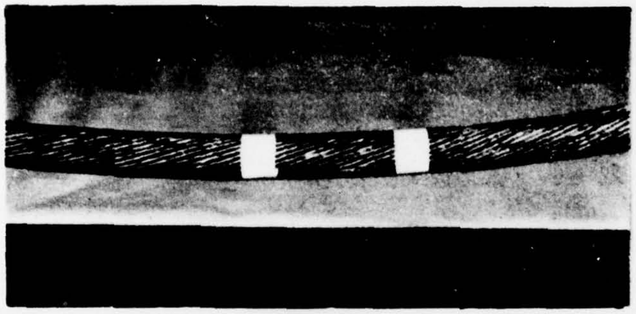

Fig. A4 - Masking strips in place

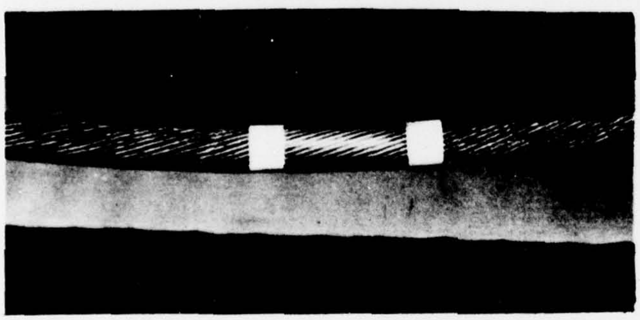

Fig. A5 - Towcable after initial wire brushing

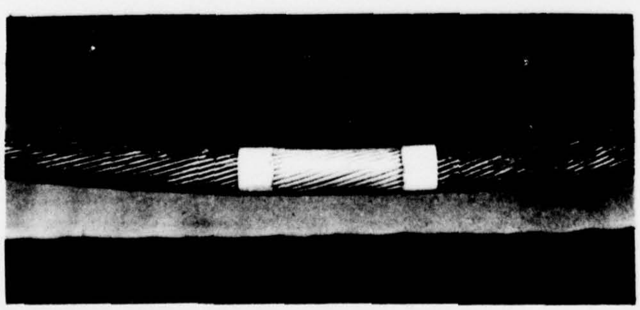

Fig. A6 - Towcable following all cleaning operations

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Figs. A3 through A6

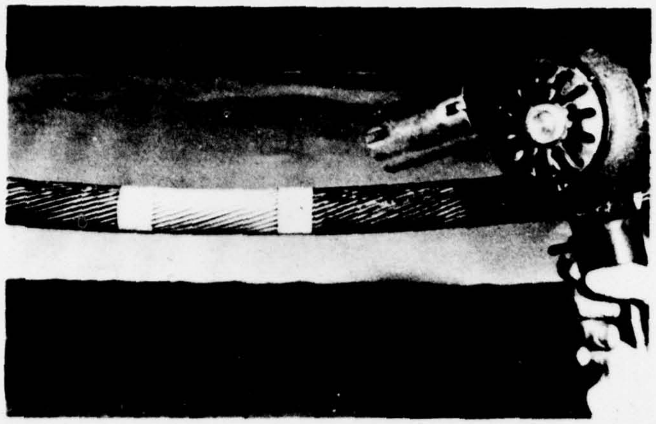

Fig. A7 - Clean area being dried with cold air from blower

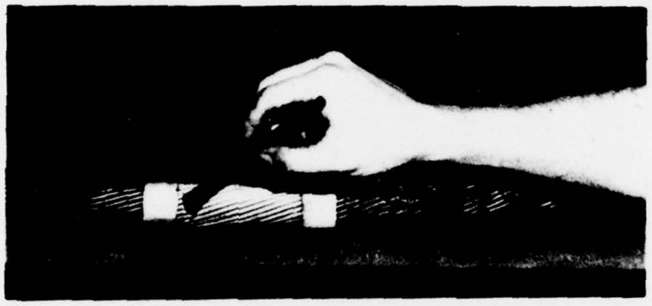

Fig. A8 - Phosphoric acid being brushed on clean area

Fig. A9 - Thixon P-4 adhesive being stirred by small laboratory mixer. Note cover to prevent evaporation of adhesive's solvents.

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Figs. A7 through A9

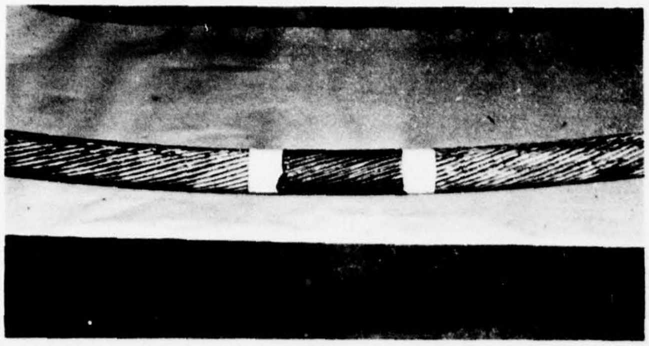

Fig. A10 - Towcable after application of adhesive

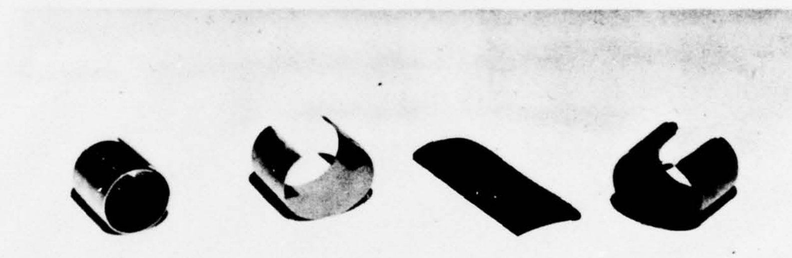

Fig A11a A11b A11c A11d

a. Fairing support ring as manufactured.

b. Fairing support ring opened to a C-shape. Inside surface sandblasted.

c. Nitrile rubber strip 5 inches long by 2 inches wide by 3/16 inch thick.

d. Rubber strip placed inside fairing support ring.

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Figs. A10 and A11

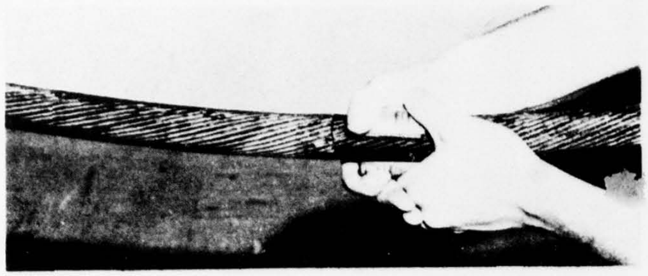

Fig. A12 - Fairing support ring being squeezed tight around the cable

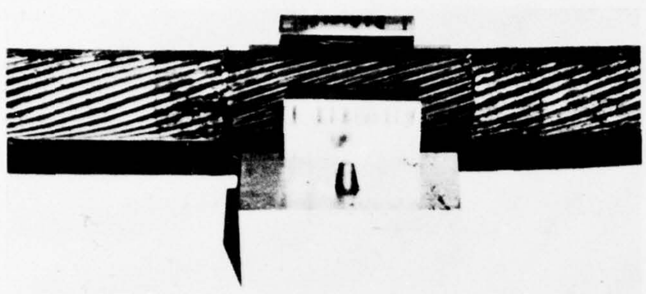

Fig. A13a

Fairing support ring positioned in bottom half of heated mold. Note that seam of ring does not coincide with separation line of mold and that the mold is centered in area coated with adhesive.

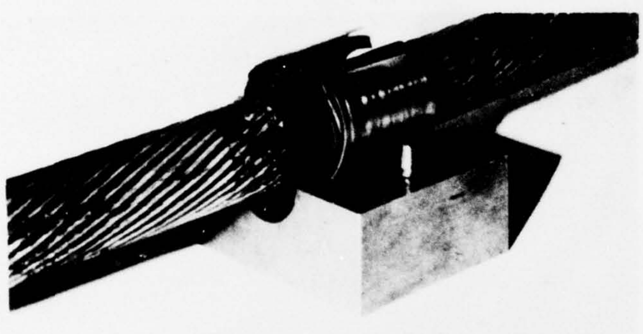

Fig. A13b

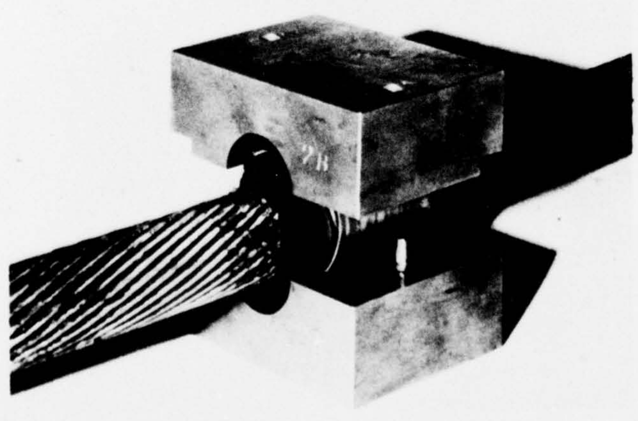

Fig. A14 - Heated top half of mold being placed on fairing support ring

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Figs. A12 through A14

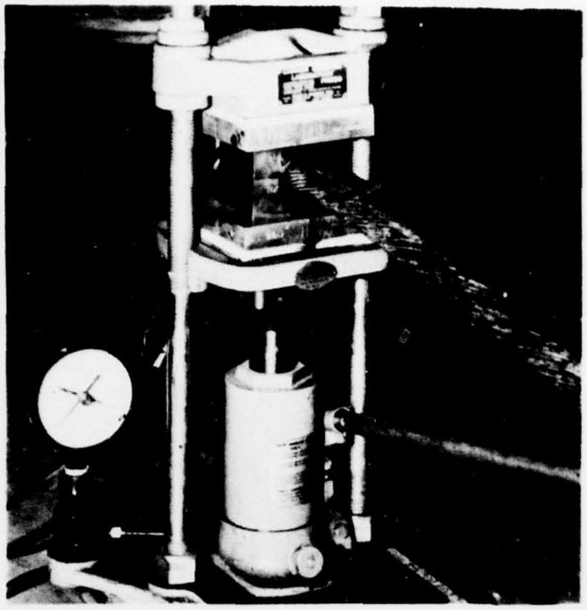

Fig. A15 - Assembled ring mold and cable in hydraulic press

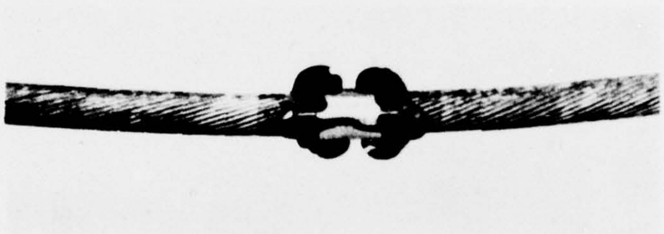

Fig. A16 - Fairing support ring as removed from mold. (Rubber outside of ring is called flash)

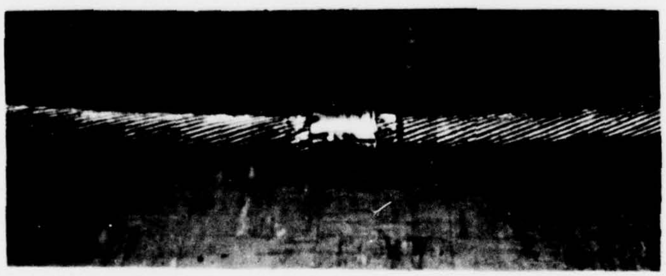

Fig. A17 - Fairing support ring with flash removed and seam tack welded

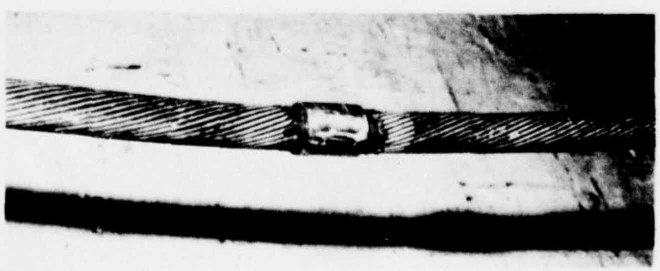

Fig. A18 - Finished fairing support ring with tack weld ground smooth

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Figs. A15 through A18